

# History of whaling, sealing, fishery and aquaculture trials in the area of the Kerguelen Plateau

by

Guy DUHAMEL\* (1) & Richard WILLIAMS (2)

**ABSTRACT.** - The exploitation of marine resources on the Kerguelen Plateau only began in 1790 (18<sup>th</sup> century) after the discovery of the northern Kerguelen Islands in 1772. Salted fur seal (*Arctocephalus gazella*) skins was the first product to be commercialized by Nantucket (USA) and London (UK) ship-owners, mainly on the Kerguelen Islands, and by the early 19<sup>th</sup> century the seal colonies were decimated. The sealing gangs shifted to extracting oil from the blubber of elephant seals (*Mirounga leonina*) with American sealing companies establishing a virtual monopoly from 1840-1895, initially in Kerguelen Islands and later (1855-1882) at Heard Island and the McDonald Islands, after their discovery in 1853. Occasionally, whaling for humpback (*Megaptera novaeangliae*) and southern right whales (*Eubalaena australis*) occurred in bay-to-bay transits. During the 19<sup>th</sup> century, more than 20 vessels were wrecked on both island groups. A Norwegian-French whaling station was established at Kerguelen Islands (Port Jeanne d'Arc) in 1908, initially hunting whales and later on elephant seals. It was active from 1908-1914, and from 1920 until its closure in 1929. The last important period of sealing was conducted from mother-ships using small catchers (1925-1931). The last sealing activity (SIDAP) took place at the Kerguelen Islands in 1963. Exploratory finfish fisheries by the Union of Soviet Socialist Republics (USSR; 1960-62), Japan (1966-67 and 1977-78) and Poland (1974-75) were conducted, leading to the arrival of a fleet of Soviet factory freezer trawlers in 1971-72, targeting Marbled Rockcod *Notothenia rossii*, Mackerel Icefish *Champscephalus gunnari* and Grey Notothen *Lepidonotothen squamifrons* over the shelf and the surrounding banks. The establishment of a 200 nm French exclusive economic zone (EEZ) off the Kerguelen Islands in 1978 and an Australian EEZ off the Heard and McDonald Islands in 1979 resulted in the closure of the unrestricted fishery. Additionally, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) was established in 1980, which resulted in the introduction of an ecosystem-based management approach in addition to the national regulations on the Plateau. Progressively, national shipowners have taken the place of foreign companies and longlining has largely replaced trawling to target a new deep-sea species, the Patagonian toothfish, *Dissostichus eleginoides*. Illegal, unreported and unregulated (IUU) fishing occurred from 1997-2004, but active patrolling, seizure of vessels and products, and satellite tracking have eradicated this plague over the Plateau. Other projects (kelp harvesting, sea-ranching of introduced Salmonidae, factory barges) have been proposed but have never been brought to fruition.

**RÉSUMÉ.** - Historique des chasses à la baleine et aux phoques, de la pêche et des tentatives aquacoles sur l'ensemble du Plateau de Kerguelen.

L'exploitation des ressources marines du Plateau de Kerguelen commença seulement au XVIII<sup>e</sup> siècle (1790) après la découverte des îles Kerguelen, les plus septentrionales, en 1772. Les peaux d'otaries (*Arctocephalus gazella*), provenant essentiellement des îles Kerguelen, furent les premiers produits commercialisés par les armateurs de Nantucket (USA) et Londres (GB) mais dès le début du XIX<sup>e</sup> siècle les colonies furent décimées. Les chasseurs de fourrures se convertirent alors à l'extraction d'huile d'éléphants de mer (*Mirounga leonina*) et les compagnies américaines s'arrogèrent un quasi-monopole durant la période 1840-1895, d'abord aux îles Kerguelen puis, plus tard (1855-1882), à l'île Heard à la suite de la découverte de cette île méridionale en 1853. Durant leurs transits de baie à baie et de manière occasionnelle, ces chasseurs pratiquaient la chasse à la baleine à bosse (*Megaptera novaeangliae*) ou à la baleine franche australe (*Eubalaena australis*). Lors du XIX<sup>e</sup> siècle, plus de 20 navires sombrèrent au large de ces îles. Une station baleinière franco-norvégienne fut construite aux îles Kerguelen en 1908 à Port Jeanne d'Arc et fut en activité de 1908 à 1914 puis de 1920 à 1929. Elle exploita d'abord les baleines puis se convertit aux éléphants de mer. Elle ferma définitivement en 1929. Une dernière phase importante d'exploitation des éléphants de mer se déroula à partir d'une flotte de navires-usines et de petits vapeurs (1925-1931). La dernière activité de chasse à l'éléphant de mer (SIDAP) s'acheva en 1963. Une pêche exploratoire aux poissons fut conduite par l'URSS (1960-62) le Japon (1966-67 et 1977-78) et la Pologne (1974-75), aboutissant à l'arrivée d'une flotte de pêche soviétique de chalutiers dès 1971-72. Ces derniers ciblaient le colin de Kerguelen (*Notothenia rossii*), le poisson des glaces (*Champscephalus gunnari*) et le colin austral (*Lepidonotothen squamifrons*) sur le plateau et les bancs avoisinants. La création d'une Zone économique française de 200 milles, au large des îles Kerguelen en 1978 et australienne autour des îles Heard et McDonald en 1979, conduisit à l'arrêt d'une pêche non réglementée. Presque simultanément la Commission pour la Conservation de la Faune et de la Flore de l'Antarctique fut créée (1980), ce qui orienta l'exploitation vers une gestion basée sur l'écosystème, laquelle s'ajouta aux mesures nationales développées pour les pêcheries de ce Plateau. Progressivement, les armateurs nationaux se sont substitués aux compagnies de pêche étrangères et la méthode de pêche à la palangre a largement remplacé celle au chalut pour cibler une nouvelle espèce pêchée en profondeur, la légine australe *Dissostichus eleginoides*. Un épisode de pêche illicite, non déclarée et non réglementée (INN) s'est déroulé de 1997 à 2004 mais une réaction rapide de patrouilles conduisant à la saisie de navires illicites et de leur production ainsi qu'une surveillance par satellite ont permis d'éliminer cette plaie qui se développait sur le Plateau. D'autres projets (récolte des algues, ferme d'élevage de salmonidae introduits, barges-usines) ont été envisagés mais n'ont pas été conduits à leur terme.

Key words. - Kerguelen I. - Heard I. - Fishery - Whaling - Sealing - History.

(1) Muséum national d'Histoire naturelle, Département des milieux et peuplements aquatiques, UMR 7208, CP 26, 43 rue Cuvier, 75231 Paris CEDEX 05, France.

(2) Australian Antarctic Division, 203 Channel Highway, Kingston, Tasmania 7050, Australia. [dick\_wil@antdiv.gov.au]

\* Corresponding author [duhamel@mnhn.fr]

Exploitation of marine species on the Kerguelen Plateau began soon after the discovery on 13<sup>th</sup> February 1772 of the northern Kerguelen islands by the expedition of Y.J. de Kerguelen de Trémarec with the *Gros Ventre* and the *Fortune*. The first sealing voyages (1791-1793) were reported from the United States of America (USA) and United Kingdom (UK) twenty years later (see Headland, 1989). For more than 50 years during this early period, sealing occurred only around the Kerguelen Islands. It was only with the development of whaling and sealing voyages in the region that sealers from the north-eastern coast of the USA discovered the second and southern sealing ground on the Plateau, Heard and McDonald Islands, during the 1853-1855 cruise of *Corinthian*. Barks and schooners with tenders were regular visitors in the 19<sup>th</sup> century, first for the fur seal skin trade market and later for the oil of elephant seals, with sealing gangs on shore, and whales (and bones) with harpooners.

The only factory whaling station (Port Jeanne d'Arc, Morbihan Bay, Kerguelen Islands) was established early in the 20<sup>th</sup> century. Simultaneous sealing and whaling were still active in the protected bays of Kerguelen Islands, but these massive operations quickly failed and a hiatus in the exploitation of marine resources followed these activities.

The discovery of fishing grounds on both the Kerguelen and Heard Islands shelves by the Soviet Union fleet in early 1970s led to a new period of activity on a single marine resource – fish, which has continued to the present. Other projects (fish farming, barges, kelp) were proposed but have never taken place.

The six major periods of the Kerguelen Plateau marine exploitation are as follows: sealing and whaling: 1790-1820 US/UK sealing voyages (Kerguelen Islands), 1840-1890 US sealing and whaling voyages, the New London monopoly (Kerguelen and later Heard Island), French Bossière leases, Kerguelen Islands 1908-1911 (Phase 1: Shore-based Norwegian whaling station, Port Jeanne d'Arc), and 1925-1931 (Phase 2: Modern sealing with steamer mother ships and catchers); fishing: 1970-1978 USSR unrestricted trawl fishery on the Kerguelen-Heard Plateau, and 1979-present (EEZ licensed fishery, including 1997-2004 IUU longline episode).

### 1790-1820: UK sealing voyages at Desolation Island

The detailed chart of the Desolation Islands (= Kerguelen Islands) from Captain Cook's third voyage where he landed at Christmas Harbour on 24<sup>th</sup> December 1776, was probably used by ship-owners to organise the early UK sealing voyages. The first sealers recorded at the Desolation Islands in 1791-1793 (Dickson, 2007), were the barks *Asia*, *Alliance* and the schooners *Hunter*, *Eleonora* from Nantucket (USA), but the first era of sealing was dominated by London ship-owners. *Chesterfield* from London (1792-1793) was the first of a succession of 51 cruises (33 different vessels) mainly

from 1792 to 1820 (the last in 1840) (Jones, 1971; 1986). During these first years of the Kerguelen Plateau marine exploitation, the sealing gangs hunted fur seals [*Arctocephalus gazella* (Peters, 1875)] for their skins. The skins were salted in barrels to be sold on the Chinese market (mainly Canton) as an exchange product. Hunting was so easy that the populations in the mainland were brought to near extinction by the beginning of the 19<sup>th</sup> century. The *Eagle* was recorded to have collected only four skins in 1817!

Master Fuller of the Schooner *Pilot's Bride*, was probably the most experienced master at Kerguelen Islands. While venturing on the least accessible offshore islands of the Kerguelen archipelago for fur seals, he discovered the last non-hunted colony on Cloudy Islands on 13 January 1881. The following year, the sealing gangs (1881-1882) exterminated this last colony, taking 2955 skins (Bousquet, 2009)!

As the virgin stock of fur seals has been estimated at 200 000 (C. Guinet, pers. comm.), the fur seal hunting can be considered to have eradicated the population in less than 20 years! The sealers quickly turned their attention to oil production from elephant seals *Mirounga leonina* (Linnaeus, 1758), which were abundant on the beaches during the harem period (September to November).

Exploitation in the early 19<sup>th</sup> century was well described in Nunn's account (1825-1829) on board the *Royal Sovereign* (Clarcke, 1850). Vessels (mainly barks of 300 to 400 t) sailed from their home port with a stop-over in the Atlantic ports for additional crew. About six boats were carried on-board and a launch of 40 t arrived in kit-form and was assembled on shore. Anchorages were in a protected bay (e.g., Pot/Betsy Harbour, Port des îles, Greenland Bay); all yards were stored and the vessels were used for cargo. Boilers were set up on-board or on-shore (large cast iron try pots) as seen at the line of eight boilers recovered at Shaloo Harbour. Tenders sailed all around the islands, taking sealing gangs to beaches for fur seals (salted skins) and elephant seals (oil from blubber transferred by rafts of floating pieces from shore to schooner/bark for boiling). Barrels in kit form were assembled for storage of skins and oil was stored in barrels. After two to three years of sealing, with full load of barrels collected, the vessels returned home leaving the tenders on the shore (e.g., *Loon*, *Favorite*, *Francès*).

### 1840-1890: US sealing and whaling voyages, the New London monopoly

This fifty year period is characterised by the New London monopoly of sealing and whaling voyages. At that time, sealers came from ports in north-eastern America (New London, Nantucket, New Bedford, Mystic, Fairhaven) and at least 34 different barks (275 to 505 t) and 28 schooners (60 to 250 t) were recorded (Starbuck, 1878; Headland, 1989). They operated both on the northern part around Kerguelen Islands (Fig. 1) and on the southern part of the Kerguelen



Figure 1. - “Desolation Island, Indian Ocean”. 19<sup>th</sup> century sealing activities of barks and schooners close by the southern shores of the Kerguelen Islands (the typical angular *doigt de sainte Anne* is visible on the left side of the painting, Black smoke indicates blubber boiling on-board vessels). © Oil painting, unidentified 19<sup>th</sup> century artist, courtesy of Mystic Museum.



Figure 2. - “Heard Island, South Indian Ocean”. Sealing gangs operating on a beach of Heard island, hunting sea elephants. The typical *Big Ben* ice-covered volcano is visible in the background. © oil painting, unidentified 19<sup>th</sup> century artist, courtesy of Mystic Museum.

Plateau around Heard (Fig. 2) and McDonald Islands after their discovery by the US sealer John Jay Heard on the *Oriental* (Heard Island, 25 November 1853) and by the British sealer William McDonald on the *Samarang* (McDonald Island, 4 January 1854) (Downes and Downes, 2006). Each vessel undertook between one and nine voyages. A well organised fleet operated at this time with an established rendezvous and water collection points. The Master Fuller of the schooner *Franklin* noted 15 vessels simultaneously at the anchorage of Port des îles and Betsy Harbour returning from their Kerguelen and Heard sealing grounds in 1860 (Bousquet, 2009), a record that has never been surpassed.

The season began from October to mid-November for elephant seals, followed by fur seals (during summer). Whaling for humpback [*Megaptera novaeangliae* (Borowski,

1781)] and southern right [*Eubalaena australis* (Desmoulins, 1822)] whales occurred before and during winter. The shore and on-board production was stored in barrels, each containing about 120 liters; an elephant seal produces one-half to seven barrels of oil (*dixit* Master Fuller from *Roswell King* in Bousquet, 2009). A whale produces about 40 barrels of oil and 275 kg of bones. The records of landings (Starbuck, 1878) give an idea of the production during this period: Bark *Corinthian* (5 cruises, 1849-1858) with 16 319 barrels and 30 036 kg whale bones; Bark *Alert* (5 cruises, 1853-1862) with 16 709 barrels and 34 600 kg whale bones; Bark *Roman* (9 cruises, 1867-1876) with 12 267 barrels and 7 519 kg whale bones; and Schooner *Charles Colgate* (8 cruises, 1862-1877) with 7 500 barrels and 1 600 kg whale bones.



The report of Taylor (1929) provides some information on the success of whaling in the eastern protected bays (Hillsborough Bay = golfe des Baleiniers) with ten whales caught (not all processed) by *Julius Caesar* during 40 days of winter chase and 6 more before leaving (March 1853) and 14 by *Corinthian*.

During 1840-1877, when records are nearly complete (102 of the 128 voyages), a minimum of 157 000 barrels of oil and 195 tonnes of whale bones were landed (Starbuck, 1878). This gives an estimated catch of more than 300 000 elephant seals and 710 whales.

Norwegian, South-African and Australian sealers joined the US sealing fleet at the end of the 19th century. The French naval voyage of *Eure* reaffirmed the French claims (January 1893) to the Kerguelen Archipelago and led to an exclusive lease to two French brothers (Headland, 1989).

### The French Bossière leases, Kerguelen Islands

#### *Phase 1, 1908-1911: the whaling station at Port Jeanne d'Arc and the Mangoro campaign (1910)*

A 50-years exclusive licence was granted to the Bossière brothers by the French Government in 31 July 1897 for the exploitation of the Kerguelen Islands. During the first period (1908-1911) they transferred the rights to two companies, Aktieselskabet Kerguelen and Société des Pêcheries de Kerguelen (Arnaud and Beurois, 1996).

The first company (Aktieselskabet Kerguelen) was a French-Norwegian association (Storm, Bull & Co.), which was active from 1908-1911. It established a whaling factory station at Port-Jeanne d'Arc in Morbihan Bay (Fig. 3). The oil carrier *Jeanne d'Arc* (76 m, 1332 t) and three whale catchers (two sister ships *Espoir* and *Éclair*, 51 m, 540 t, and *Etoile*, 30 m, 165 t) were linked to the station.

The total whale catch resulting from this activity was 442 whales (95% humpback, the balance right whales). Their best year was in 1908 when 232 whales were caught and a total of 13 760 barrels of oil were produced. Activity progressively shifted to hunting elephant seals with peak production in 1911 of 10 680 barrels and a total production of 17 000 barrels of oil. However, the activity was not profitable enough and the station fell into disuse.

The second company (Société des Pêcheries de Kerguelen) caught 44 whales using the *Mangoro* (86 m, 2054 t) for whaling with the whale catcher *Ornen* from March-June 1910. The *Mangoro* also visited Heard Island (Headland, 1989)

Activities were interrupted for some years before a second sealing period.



Figure 3. - The French-Norwegian whaling station at Port Jeanne d'Arc, Morbihan Bay, Kerguelen Islands, first established 1908. Two views of the factory and buildings in 1979. (photos © G. Duhamel)

#### *Phase 2, 1925-1931: modern sealing with steamer mother ships and catchers*

The second period corresponds to the contemporary sealing voyages of two companies, Pêches Australes and Kerguelen Sealing and Whaling Company, which operated in different sealing grounds around the Kerguelen Archipelago (Arnaud *et al.*, 2007).

The French Pêches Australes hunted in the northern part of the Kerguelen Islands and first used (1925-1928) the *Lozère* (88,6 m, 2365 t) for three sealing voyages with the motor-boats (5 m) *Pinguin*, *Léopard* and *Claire* (first cruise), the trawler *Arques* (33 m, 211 t) for the second cruise (lost 13 December 1927) and the Dundee *Marie-Madeleine* (14,6 m, 24 t) for the third cruise, which was beached and lost. The *Lozère* sank on 12 February 1928 with the loss of the entire production of the third cruise. A total of 50 223 elephant seals were slaughtered for 2 734 tons of oil. The *Lozère* was replaced by *Austral* (101 m, 2891 t) for three sealing voyages from 1928-1931 using the steamer *Espérance* (40 m, 350 t, beached 23 March 1931) (Fig. 4) and motor-boats *Pinguin*, *Léopard*, *Jaguard* and Dundee *Marie-Madeleine*. These voyages produced 2 130 tons of oil from 36 000 elephant seals.

The Anglo-Norwegian Kerguelen Sealing and Whaling





Figure 4. - The steamer *Esperance* (Kerguelen I. sealing activity, 1928-1931) beached on the île du Chat, Morbihan Bay, Kerguelen Islands. (photo 1979 © G. Duhamel)

Company was allocated the southern part of the Kerguelen archipelago. The *Radioleine* with *Kildalkey*, *Inhof*, *Ben Edra* and *Borowby* operated from October 1927 until end of February 1928 with 40 000 elephant seals slaughtered and 3 200 tons of oil (11 700 barrels) produced (Arnaud *et al.*, 2007). The factory ship with whale-catchers made occasional sealing voyages to Heard Island (Headland, 1989).

The partition of the sealing grounds was not always respected by the second company and legal proceedings were threatened by the lease's owners (reported in the New York Times in 1908 under the title *French may tackle Yankee sea captain*). The sealing method was virtually the same as that in the early 19<sup>th</sup> century (sealing gangs, blubber boiling) as contemporary paintings and photographs prove. The most profitable cruises were clearly for the second company.

A small land-based factory, La Petite Usine, was established at Port Couvreur (northern Courbet Peninsula) during this period but was not used for large-scale production; only 2-3 t of oil from 40-60 elephant seals were recorded (Arnaud *et al.*, 2007).

To summarize, a minimum of 126 000 elephant seals were killed for oil from 1925-1931.

The last exploitation of the Kerguelen Islands elephant seal colonies was carried-out on a more controlled basis by the Société Industrielle des Abattoirs Parisiens (SIDAP) based in Port-aux-Français from 1957-1963 under the direction of M. Péchenart. The Society used a Bren-carrier (Péchenart, 2003) to carry the seal carcasses (only bulls) from the eastern beaches to the factory where they were processed; not only for oil from the blubber but also for meal from the whole body, with a high mean yield (232 kg per bull) (Bajard, 1962 in Arnaud *et al.*, 2007). The reported annual catches fluctuate from 553 to 1 063 bulls (from 1958-1961) and the estimated total number of killed seals was about 6 000 bulls (Pascal, 1982).

There was a hiatus in the marine exploitation on the Pla-

teau after this important sealing period until early 1970 when modern fishing activity with factory freezer stern trawlers began in the Southern Ocean. First USSR scouting vessels discovered the fishing grounds (1958-1960 and 1961) and then fishing exploration took place with *Aelita* in 1967-1969. The subsequent unrestricted fishery by a USSR fishing fleet began a period during which catches up to the present have totalled 1 012 166 t (1971-1972 to 2008-2009), coming both from the Kerguelen (91.3%) and Heard (8.7%) zones of the Kerguelen Plateau. The creation of EEZ in the late 1970s forms a natural division of the fishery into two main periods.

### The USSR unrestricted trawl fishery: 1971-1972 and 1977-1978

The USSR fishing fleet was rapidly deployed in the Indian sector of the Southern Ocean, with 7-40 trawlers operating, sometimes together, and the intense fishing activity was reflected in the official landing statistics (Fig. 5) [Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), 1990-2008]. The trawlers mainly originated from the Black Sea ports of Odessa, Sevastopol, Kerch and Novorossiysk, but used the Indian Ocean ports of Port-Louis and Maputo for shipyard facilities, maintenance, supply of goods and crew movements. Carriers (for transferring the processed catch) (see Anonymous, 1972) and fuel tankers regularly visited the Kerguelen islands to rendezvous with trawlers at Port des Îles and Pointe Mollo in Morbihan Bay. This self-governing fleet (Fig. 6) typically used the robust *Atlantic* type trawlers (RMT: 82 m) as well as some scientific trawlers such as *Skiff*, *Kara-Dag* and later *Mys Ostrovkogo*. The duration of fishing cruises could reach six months and the only opportunity for the crew to go ashore was when the trawlers needed to fill their water ballasts, usually at the well-known Lozère Cascade at Hopeful Bay, Kerguelen Islands (the same water point that was used during the sealing period), or in case of accident, at the hospital facilities at Port-aux-Français, Morbihan Bay. Fishing activities took place on the shelf and slope of the islands and surrounding banks targeting three main species of fish: marbled rockcod (*Notothenia rossii* Richardson, 1844), mackerel icefish (*Champsocephalus gunnari* Lönnberg, 1905) and grey notothen (*Lepidonotothen squamifrons* (Günther, 1880)). Heard Island was sporadically exploited for icefish during this period (Fig. 5).

Polish (1974-1975 *Professor Siedlecki*, 1977-1978 *Manta*) (Slosarczyk and Wysokinski, 1980; Sosinski, 1981) and Japanese (*JAMARC*, 1977-1978) scientific trawlers explored the fishing grounds off Kerguelen and Heard islands at the same period but these countries never deployed a fishing fleet.

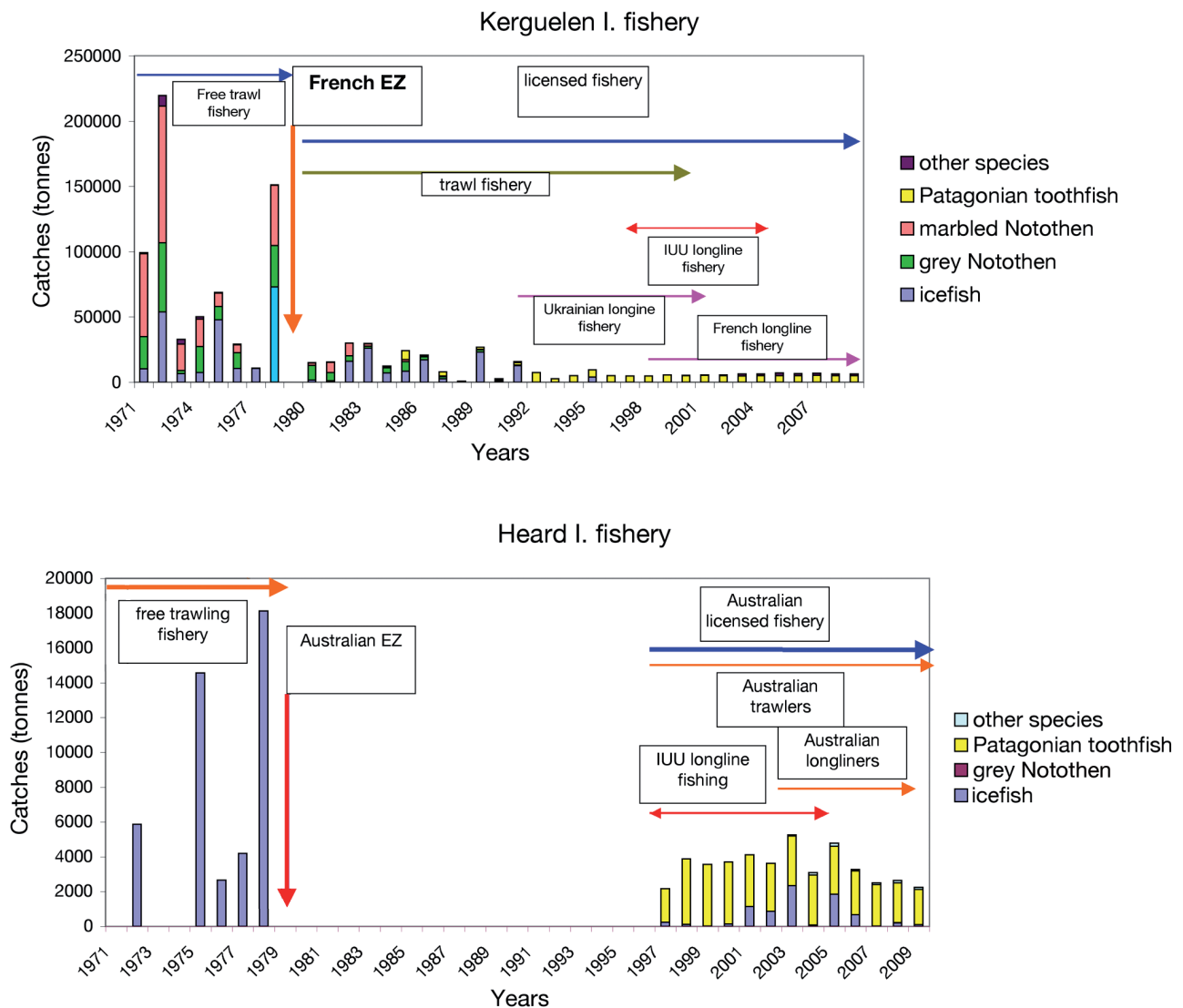


Figure 5. - Historic total catches by species in the Kerguelen (top) and Heard (bottom) islands fisheries. (Note that the catches scales are different.)

### The EEZ licensed fishery 1979-present and the 1997-2004 IUU longline episode

The establishment of EEZs (French around Kerguelen Islands in 1978 and Australian around the Heard and McDonald Islands in 1979) and the promulgation of the first fishery regulations led to the replacement of the unrestricted fishery on the Kerguelen Plateau with licensed fisheries. However, each country has differed in its fishery management approach and the history of fisheries in the two EEZs needs to be considered separately.

#### The Kerguelen Islands licensed fishery

##### The foreign fishery 1979-1999 (trawlers and longliners)

France finalised fishery agreements before the re-open-

ing of the fishing grounds (October 1979). A total of seven agreements were signed with the USSR between 1979 and 1991 with total allocation of 250 750 t during this period, and reported catch was 189 470 t. Five agreements were then signed with Ukraine from 1992-1998 for a total allocation of 22 050 t. No more than seven licensed trawlers and two longliners were allowed to fish simultaneously. Only the western sector of the shelf was opened for longlining from 1990-1991 to 1998-1999 (Tab. I). Nearly 50 different trawlers: 39 Atlantic RMT, 82 m 2 177 t, 1 BRMT, 84 m, 2 325 t, 1 MAHANOVIC 85 m 2 261 t, 5 super-Atlantic SRMT 102 m, 3 090 t, 2 PRT, 104 m, 4 020 t, 1 scientific trawler 75 m; and 4 longliners (54 m, 775 t) were registered for the total period of fishing activity.

The first regulations introduced in the fishery included



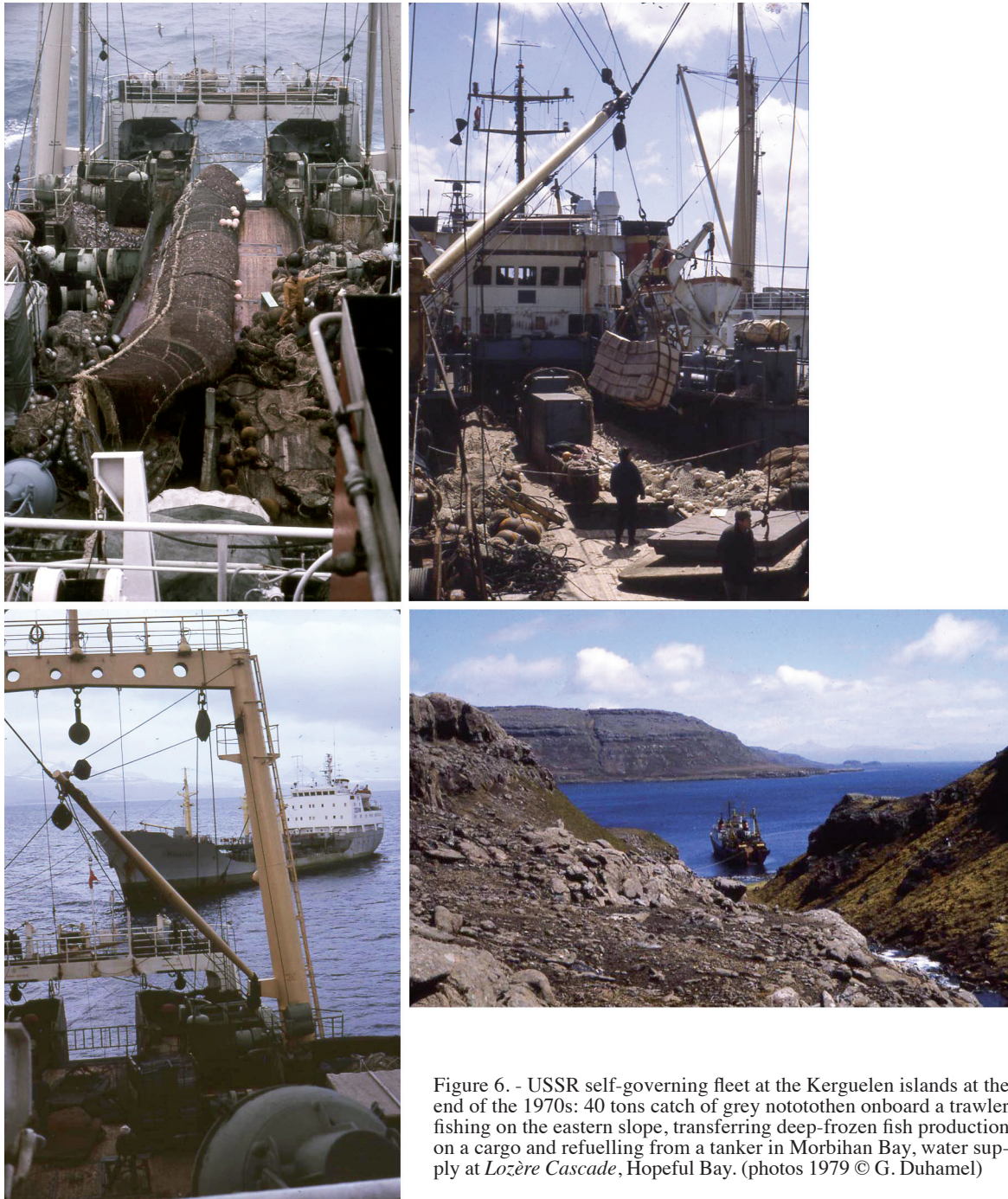


Figure 6. - USSR self-governing fleet at the Kerguelen islands at the end of the 1970s: 40 tons catch of grey notothen onboard a trawler fishing on the eastern slope, transferring deep-frozen fish production on a cargo and refuelling from a tanker in Morbihan Bay, water supply at *Lozère Cascade*, Hopeful Bay. (photos 1979 © G. Duhamel)

completion of logbooks, mesh size limitations and carriage of fishery observers on-board (Duhamel, 1995) and were designed to improve the knowledge of the fishery and to begin management of the resource. Joint USSR-France scientific surveys (*SKALP*) were conducted with the research trawler *Skif* during 1987 and with *Skif* and *Kalper* during 1988 (Duhamel, 1993). The naval ship *Albatros* also made its first patrol in 1984.

Another fishery agreement was signed in 1979 with Poland but only one trawler (*Lacerta*) was sent on the fishing grounds.

#### *The French trawl fishery 1979-2001*

The *Sapmer II*, a side trawler owned by the Société Anonyme de Pêche Malgache et Réunionnaise (SAPMER) from Réunion Island, was the first to conduct trawling tri-

Table I. - Fishery agreements between France, USSR and Ukraine in the Kerguelen I. EEZ from 1979 to 1998. (TOP: *Dissostichus eleginoides*, ANI: *Champtocephalus gunnari*, NOS: *Lepidonotthen squamifrons*, NOR: *Notothenia rossii*; t = trawler, l = longliner)

Number	Date of agreement Country	Dates of application	Maximum number simultaneously		Fishing days on grounds Maximum	Allowed total catch (tonnes)	Maximum catches (tonnes)			
			Trawlers	Longliners			TOP	ANI	NOS	NOR
1	July 1979 USSR	29/09/1979-29/02/1980	7	0	842	16 000	-	-	-	-
		1/06/1980-31/12/1980 Prorogation 31/03/1981	7	0	1 000	19 000	-	-	-	-
2	22/11/80 USSR	1/07/1981-30/09/1982	7	0	1 580	30 000	-	-	-	-
3	02/08/1982 USSR	1/10/1982-30/09/1982	7	0	1 315	25 000	-	-	-	-
		1/10/1983-30/09/1984	7	0	1 315	23 000	-	-	-	-
4	03/08/1984 USSR	1/10/1984-30/09/1985	7	0	1 315	20 000	-	13 000	5 000	2 000
		1/10/1985-30/09/1986	7	0	1 315	19 750	-	12 600	6 000	1 150
5	18/08/1986 17/07/1987 USSR	1/10/1986-31/12/1987	7	0	1 315	20 000	-	16 000	5 000	500
		1/01/1988-31/09/1988 Prorogation 31/12/1988	7	0	1 315	17 500	-	12 500	2 000	500
6	05/11/0988 17/07/1989 14/11/1990 USSR	1/01/1989-30/09/1989	7	0	800	10 500	-	7 500	1 000	400
		1/10/1989-30/09/1990 1/01/1991-30/09/1991 Prorogation 31/12/1991	7	0 2 (> 500 m)	800 t: 800, l: 240	16 000 17 000	-	12 000	1 000 2 000	500 500
7	14/11/1991 USSR	1/01/1992-31/12/1992	7	2 (> 300 m sectors 3 and 4)	t: 800, l: 240	17 000	-	12 000	2 000	500
1	10/12/1992 25/11/1993 Ukraine	1/01/1993-31/12/1993	3	2 (3 from 15 to 30/12/1993)	-	6 500	l: 1 000 (sectors 3, 4) t: 1 800 (sector 251) l: 1 600 (sectors 3, 4)	1 000 (sector 4)	2 000 (sector 1)	500
		1/01/1994-31/12/1994	3	3	-	6 600		5 000 (sector 2)	-	-
2	16/12/1994 Ukraine	1/01/1995-31/12/1995	3	3	-	5 950	l: 950 (sectors 3, 4)	5 000 (sector 2)	-	-
3	10/11/1995 Ukraine	1/1/1996-31/12/1996	0	2	-	1 000	l: 1 000 (sectors 3, 4)	-	-	-
4	15/11/1996 Ukraine	1/01/1997-31/12/1997	0	2	-	1 000	l: 1 000 (sectors 3, 4)	-	-	-
5	24/11/1997 Ukraine	1/01/1998-31/12/1998	0	2	-	1 000	l: 1 000 (sectors 3, 4)	-	-	-

als on the inshore shelf during 1968 but the catches were not satisfactory (Duhamel and Hureau, 1981). Another fishery exploration, supported by Fonds d'Intervention et d'Organisation des Marchés (FIOM), was conducted after the EEZ was established with the stern trawler *Jutland* (87 m, 1 592 t), from the Bordeaux company Société Nouvelle des Pêches Lointaines (SNPL) (Anonymous, 1979). As a result, three trawlers (*Zélande*, a sister ship of *Jutland* from SNPL, *Austral* 78 m, 1 379 t, from SAPMER and *Sydéro*, 60 m, 836 t, from Armement des mers du Sud) were deployed for two seasons (1981-1982) targeting mainly *N. rossii* during winter time (Fig. 7). However, the market price of the fish product was not high enough to be profitable for the companies. Only one trawler *Austral* continued to fish from 1981-1992 with annual cruises targeting *C. gunnari*. Exclusive quotas for rock lobster around the Saint-Paul and Amsterdam Islands (other French EEZs in the subtropical Indian Ocean) compensated for these unprofitable fishing cruises.

After the discovery of commercial quantities of the very high-priced Patagonian toothfish (*Dissostichus eleginoides* Smitt 1898), in the deep waters of the Kerguelen Plateau, new (*Austral*, 78 m, 1 697 t, from SAPMER) or refitted [*Kerguelen de Trémarec*, 87 m, 1 597 t from Compagnie Maritime des Terres Australes (COMATA)] French factory stern trawlers appeared on the fishing grounds in 1993. The availability of this high value species led to a resurgence of interest in the Kerguelen EEZ by French ship-owners.





Figure 7. - French trawlers *Austral* and *Sydero* on the fishing grounds of marbled notothen during winter in 1982. (photo © G. Duhamel)

Trawling was discontinued in 2001 when the shift from trawling to longlining was fully achieved as a management measure for the stock. The only recent occurrence of a trawler off Kerguelen Islands was during the French biomass survey cruise *POKER* of *Austral* during September-October 2006 (Duhamel and Hauteceur, 2009).

#### *The French longline fishery 1997-present*

A joint Japanese-French longline survey was conducted in 1996-1997 with *Anyo-Maru 22* to evaluate the longline potential in deep waters. This was followed by the first French longlining voyages (from 1997-1998) using chartered longliners with the Spanish double line system (*Northern Pride/Cap Kersaint, Cap George*), or the Japanese single line system (*Saint Paul, Aldebaran 1, Esperance-Anyo*) or autoliners (*Antarctic 1*). The first voyage by a French longliner, *Croix du Sud 1*, occurred in 1999-2000 and she was later joined by a fleet of 55 m autoliners comprising *Albius, Cap Horn 1, Ile Bourbon, Ile de la Réunion, Azmina/Mascareignes 3* and *Saint-André* built in the Concarneau shipyard by six ship-owners (Armement des Mascareignes (Armas), Le Garrec/Cap Bourbon, COMATA, Les Armements réunionnais, Pêche et Avenir, SAPMER).

#### ***The Heard Island licensed fishery: 1997-present***

The creation of the Australian 200 mile EEZ around the Heard and McDonald Islands (HIMI) in 1979 did not result in fishery agreements with foreign countries in this southern part of the Kerguelen Plateau. A joint Soviet-Australian fisheries exploration was conducted in 1987 (Gherasimchuk *et al.*, 1988) with the Ukrainian vessel *Professor Mesyatsev*, mostly investigating stocks of icefish on shelves and banks known from the unrestricted fishing period prior to the establishment of the EEZ. Later, three Australian surveys (1990-1993) with *Aurora Australis* were conducted to estimate fish



Figure 8. - The trawler *Southern Champion* operating in the Heard Island icefish and Patagonian toothfish licensed fisheries. (photo © R. Williams)

stocks on the shelf, slope and surrounding banks in the EEZ (Williams and De la Mare, 1995).

The first regular annual fishing off the Heard and McDonald Islands took place in 1997 with the licensed Australian vessel *Austral Leader*. From 1997 to the present, one to two licensed Australian trawlers *Austral Leader* (1997-2004) and *Southern Champion* (Fig. 8) (1999-present) targeted both Patagonian toothfish and Mackerel icefish, and *Sil* made one voyage in 1998 but had to be towed from Heard to Kerguelen Islands by *La Curieuse* in June 2008 due to gear engaged in the propellers (Anonymous, 2000).

Longlining for Patagonian toothfish began in 2003 with the Australian autoliner *Janas* (used from 2003-2004 and 2006-2008) and continued with *Avro Chieftain* in 2005, *Antarctic Chieftain* in 2009 and *Austral Leader II* in 2008-2009. All these vessels used integrated weight line which improves sink rate of the line and, together with other measures, has virtually eliminated bycatch of sea birds in this fishery.

Trials with pots to catch Patagonian toothfish were undertaken in 2006 and 2008 from *South Princess* and *Austral Leader II* with little success.

The activity now concerns one trawler (*Southern Champion*) targeting icefish and Patagonian toothfish and two longliners *Antarctic Chieftain* and *Austral Leader II* targeting the second species.

#### **1997-2004: chronicles of pirates poaching**

The IUU fishing of Patagonian toothfish with longliners occurred when the market price of the species increased (Duhamel, 2003). The first observations of unlicensed longliners occurred in 1997 in the vicinity of both Kerguelen and Heard islands. This followed intensive IUU fishing in other Indian Ocean sector fishing grounds to the west of

Table II. - List of IUU longliners arrested in the two EEZs of the Kerguelen Plateau (1997-2004).

	Kerguelen I. EEZ	Flag	Heard I. EEZ	Flag
1997	<i>Kinshu Maru</i> <i>Arbumasa Xxv</i> <i>Magallanes I</i>	Argentine Belize Argentine	Salvora Aliza Glacial	Belize Panama
1998	<i>Praia Do Rostello</i> <i>Mar Del Sur Dos</i> <i>Explorer (ex-Krill)</i> <i>Suma Tuna</i> <i>Golden Eagle (ex-Celine, ex-Bordo-Yarnes)</i> <i>Ercilla</i> <i>Antonio Lorenzo</i> <i>Mar Del Sur Dos</i> <i>Vierasa Doce</i> <i>Mar Del Sur Uno</i>	Portugal Belize Panama Belize Vanuatu Chile Chile Belize Argentine Chile	Big Star	Seychelles
2000	<i>Monte Confurco</i> <i>Vedra (ex-Antarcftic Flower)</i> <i>Grand Prince</i>	Seychelles Sao Tome e Principe Belize		
2001	<i>Castor (ex-Salvora)</i>	Saint Vincent & Grenadines	South Tomi	Toyo
2002	<i>Eternal (ex-Camouco, Arvisa I)</i>	Nederlandse Antillen	Lena Volga	Russia Russia
2003	<i>Lince</i>	Seychelles	Maya 5 Viarsa	Uruguay Uruguay
2004	<i>Apache</i>	Honduras		
	20 longliners		8 longliners	

Figure 9. - The last (2004) arrested IUU autoliner *Apache* in the Kerguelen EEZ. (photo D.R.)

the Kerguelen Plateau. Several confrontations of IUU longliners with licensed vessels and the necessity to uphold sovereign rights over the EEZs led to action by French and Australian naval vessels. The result was a succession of apprehended IUU longliners by naval vessels in the same year, both off Kerguelen (*Kinshu Maru*, *Arbumasa XXV*, *Magallanes*) and Heard (*Salvora*, *Aliza Glacial*). From

1997-2004, more than 60 different longliners were operating, but only 28 (Tab. II) were arrested and taken to French or Australian ports, where seizure of the vessels and their catch took place after prosecution in the courts (Fig. 9). It was a difficult and costly eradication because the IUU fleet immediately responded by taking evasive measures such as reflagging of vessels, use of high-tech radars to maintain a safe distance from licensed fishing vessels and patrol ships, at-night operations and at-sea transfer of catch. To complement the at-sea deterrence of IUU vessels, international and national actions were implemented to stop IUU catch being traded on international markets, such as the creation of a CCAMLR DCD (*Dissostichus* Catch Document) to certify the legal origin of the fish, and the establishment of a CCAMLR list of vessels engaged in IUU activity. Counter measures at sea were improved by joint Australian-French patrols in the Kerguelen and Heard EEZs, the use of radar satellite tracking (Radarsat) to detect IUU activity and the use of new patrol vessels by Australia (*Southern Supporter*, 2001; *Oceanic Viking*, 2004) and France (*Osiris*, ex IUU vessel *Lince* 2004; see Anonymous, 2003). These measures were very successful and 2004-2005 is considered to be the last year of IUU longline fishing in the two EEZs, although such activity still remains in other parts of the CCAMLR area (longlining and recently gillnetting). Two notable epi-



sodes of the IUU fishing in the EEZ were, first, the hot pursuit by an Australian patrol boat of IUU longliner *Viarsa* for 21 days from Heard Island to the mid Atlantic Ocean in August 2003 (Knecht, 2006) and the shipwreck of the IUU longliner *Aamor* (14 lives lost) to the NE of Kerguelen Islands on 9 October 2000 (Anonymous, 2001).

### Other marine exploitation

The only other marine exploitation trial has been farming salmonids for sea ranching at Kerguelen Islands. Trout (*Salmo trutta* Linnaeus, 1758) were first introduced to Château and Studer Rivers in 1962 and North River in 1986 on the Courbet Peninsula (Davaine, 2009). The fish colonised other rivers *via* coastal sea waters. In 1975, the Atlantic salmon (*Salmo salar* Linnaeus, 1758) was also released in Korrigans River, opening into Morbihan Bay. In 1981, 8 500 fingerlings from Danish eggs were released. There was a partial migration to sea but few fish returned (Davaine, 2000). A pilot farming station *Aquasaumon Armor* (Fig. 10) for sea-ranching of North Pacific species of salmon, *Oncorhynchus* spp., was also attempted in 1984 but failed and was closed some years later for economic reasons (Duhamel *et al.*, 2005).

Other marine living resources projects such as kelp (*Macrocystis pyrifera* (Linnaeus) C. Agardh, 1820) exploitation for alginates and carageenans and a marine factory barge for fishery production were considered for Kerguelen Islands but never took place.

## CONCLUSION

### The impact on marine life

The first accounts of marine exploitation were not very detailed. The logbook keeper of *Asia* (S. Crosby) reported for a three-month cruise beginning in 17 December 1792: “*more than a thousand elephant seals for their blubber, quantity of fur seals for skins and some leopard seals for meat*” (Dickson, 2007). Later reports gave the number of killed seals (or whales) in the daily logs of sealing gangs, the number of oil barrels produced, and weight of whale bones (see narratives on the *Royal Sovereign* and *Favorite* 1825-1829 in Clarke, 1850; on the *Franklin* 1859, *Roswell King* 1873-1875, *Pilot's Bride* 1880-1883 from Fuller in Bousquet, 2009; *Antarctic* 1893-1894 in Bull, 1896; *Julius Caesar* 1851-1853 in Taylor, 1929; and Starbuck, 1878).

Because catches from the beginning of exploitation to the mid 20<sup>th</sup> century were not regulated on the Kerguelen Plateau, there has been a severe impact on a number of species. First, sealing led to the eradication of Kerguelen fur seal (*A. gazella*) colonies, probably involving more than 200 000 seals, in the early exploitation period (1790-1820), and recovery of the population only began towards the end



Figure 10. - The salmon pilot farming station *Aquasaumon Armor* in Morbihan Bay, Kerguelen Islands (photo © G. Duhamel).

of the 20<sup>th</sup> century. Green (2006) stated that the first pups were observed at Heard Island in 1963 and the total island count reached 29 256 in summer 2001 (Page *et al.*, 2003). Recovery also occurred at the Kerguelen Archipelago. (Guinet *et al.*, 1996) with a minimum of 11 000 at Cloudy Islands in 1984. Up to 426 000 elephant seals were taken from 1820-1931 and the last exploitation from 1957-1963, but the Plateau population was spared to some extent by the end of industrial use of animal oils at the beginning of the 20<sup>th</sup> century. However, breeding stocks steadily declined until the last quarter of the 20<sup>th</sup> century (Pascal, 1985; Slip and Burton, 1999), the cause of which is not clear. The present trend shows a recent stabilisation (Guinet *et al.*, 1999) which needs to be confirmed. The Kerguelen Plateau has never been a major area for whaling but the few species occurring in the inshore waters have been significantly affected. About 1 200 whales (humpback and southern right) have been killed to date, half during the sealing/whaling voyages of the New London sealing and whaling era and the other half during the Port-Jeanne d'Arc whaling station activity together with modern whaling campaigns. Current observations of these two major hunted species suggest they are still very rare on the Plateau (Robineau and Duhamel, 2006) and it is premature to conclude a recovery is beginning. Finally, four species of fish were targeted by trawlers and longliners from the second part of the 20<sup>th</sup> century to the present because fishery is still operating. The total catches (1971-2008) reach 297 825 t for the marbled notothen *N. rossii*, 390 450 t for the mackerel icefish *C. gunnari*, 196 045 t for the grey notothen *L. squamifrons* and 195 835 t for the Patagonian toothfish, *D. eleginoides* (138 950 t for the licensed fishery and about 56 885 t for the IUU fishing). Fishing, especially in the unrestricted period before 1978, overexploited the stocks of *N. rossii* and *L. squamifrons*, which have to date shown few signs of recovery. Only two species, *D. eleginoides* and *C. gunnari*, presently have stocks allowing sustainable



Figure 11. - Wrecked sealing gang surviving in Kerguelen Islands [from a wood engraving in John Nunn narrative of the wreck of the *Favorite* 1825-1829 (Clarke, 1850)].

catches under the national or CCAMLR conservation measures. The IUU fishing, still a plague in the vicinity of the Plateau, keeps the equilibrium fragile.

### Sidelights of marine exploitation history

Human activity on the Kerguelen Plateau was clearly more intense in the 19<sup>th</sup> century than now because both the number of vessels simultaneously present and the level of exploitation of marine resources was higher.

The situation of Kerguelen and Heard in the ‘roaring forties’ and ‘furious fifties’ with constant gales, badly situated anchorages and the presence of icebergs in the foggy or snowing conditions has led to a lot of wrecks. Twenty major wrecks are recorded (see Headland, 1989), sometimes with the loss of all hands, such as the *Shaw Perkins* in 1847. The first wrecks were the bark *Eleonora* at Kerguelen Islands on 4 February 1793 and the tender *Alfred* of the bark *Samuel Robertson* at Heard Island in 1856. The last (except for an IUU longliner, see below) was a USSR tanker *Makatsaria* in 1980 on the *Terror Reefs*, Kerguelen Islands, caused by a navigation fault after having refuelled trawlers in *Morbihan Bay* (Le Petitcorps, pers. comm.).

Some shipwrecked sailors survived in huts or natural excavations for up to three years. Four men of the *Favorite* survived on Kerguelen Islands from 1825-1829 (Fig. 11) and 31 of the crew of the bark *Trinity* lived on Heard Island from 1880-1882 (see Clarke, 1850; Headland, 1989; Calle, 1997; Bousquet, 2009). They ate elephant, fur and leopard seals, eggs of penguins and flying birds [albatrosses, petrels, a small endemic duck, the Kerguelen pintail *Anas eatoni* (Sharpe, 1875)], some marine coastal fish (*Channichthys*

*rhinocerus* Richardson, 1844 named “gurnards”, small nototheniids *Paranotothenia magellanica* (Forster, 1801) and *Notothenia cyanobranchia* Richardson, 1844 and skates *Bathyraja* spp.), mussels under or on the rocks at low tide, the well-known Kerguelen Cabbage *Pringlea antiscorbutica* R. Br. ex Hook. F., 1845 and utilized the leaves of *Acaena magellanica* (Lam.) Vahlov as an infusion. They used wreck debris for protection and tools, seal oil as light and heating and seal skins for clothing but the conditions of life were severe. Small boats were rebuilt to do bay-to-bay expeditions but there was a major risk of being wrecked again.

Many sailors were buried on shore, the first being the master of *Alliance*, Captain Coffin, at Kerguelen Islands, on 9 February 1793 (Dickson, 2007). Two well-known cemeteries are located at Betsey/Pot Harbour (Anse Betsy) on the northeastern part of Courbet Peninsula and at Cemetery Island (Morbihan Bay) on Kerguelen Islands, and other burial places are located on both Kerguelen Islands and Heard Island. The last French sailor (C. Saunier of *Austral*) died in 1981 during the rescue of two French fishery observers on-board USSR trawlers transferring fish in Morbihan Bay, using a rubber boat in rough seas. This was related to a request for political asylum by the USSR team chief of a joint experimental scientific rocket program at Port-aux-Français.

Life on-board was sometimes a family affair for masters of sealing vessels because their wives (and sometimes children) accompanied them during the voyages and happy events were noted such as the first births (Mrs Williams on-board *Franklin* and Mrs Robinson from *Offley* respectively give birth to a girl on 25 December 1852 and to a boy on



11 March 1853) at Kerguelen Islands. The women's life on-board the barks was luxurious compared with the crude conditions of life for the sealing gangs. Taylor (1929) gives details of their life "... a comfortable room had been erected on the deck (of the Julius Caesar) for her express accommodation and now contained a neat little cooking stove, a table, sofa and chair, and had a direct communication with the cabin below...". The Peruvian "... possessed quite an attraction in the person of Miss Mary, who was ever ready to entertain her friends either seated at her piano or in cheerful conversation...". Finally the first marriage, of Marc Péchenart of SIDAP to Martine Raulin, was celebrated on 16 December 1957 at Port-aux-Français and again concerned people linked to marine resources exploitation!

**Acknowledgements.** - We thank the MNHN librarian (Ms Michèle Lenoir) for having the opportunity to purchase Taylor's narrative (1858). We are grateful to The Mystic Seaport Museum for authorising us the reproduction of two of their oil paintings on the early life of US sealers at Kerguelen and Heard Islands. We thank Jean-Marie Le Petitcorps for refreshing memories about fishing related events and Christophe Guinet for information about present and previous status of fur seals populations.

## REFERENCES

- ANONYMOUS, 1972. - Pêcheurs en Antarctique. *Pêche Mar.*, 1130: 331-333.
- ANONYMOUS, 1979. - Trois expériences de redéploiement aidées par le FIOM. *Pêche Mar.*, 1220: 629.
- ANONYMOUS, 2000. - Médaille de sauvetage maritime remise à Philippe Vié et Tanguy de Kerros à Paris, le 18 janvier 2000 suite au sauvetage du *Sil* en juin 1998. *AMAPOF*, 47: 12-13.
- ANONYMOUS, 2001. - Nouvelles maritimes. Les pillards des mers australes. *AMAPOF*, 49: 16-18.
- ANONYMOUS, 2003. - Pêche illicite, suite... *AMAPOF*, 53: 19.
- ARNAUD P. & BEUROIS J., 1996. - Les Armateurs du Rêve. Les Concessions Bossière et les Sociétés françaises d'Exploitation des Îles australes de l'Océan Indien (1893-1939). 116 p. Marseille: F. Jambois.
- ARNAUD P., BEUROIS J., COUESNON P. & LE MOËL J.F., 2007. - Phoquiers de la Désolation. La Chasse aux Éléphants de Mer aux Îles Kerguelen par les Navires-Usines français (1925-1931). 268 p. Gémenos: F. Jambois.
- BOUSQUET J.C., 2009. - Capitaine Joseph J. Fuller. Le Maître de la Désolation, 35 Ans aux Îles Kerguelen (1860-1895). 414 p. Ginkgo.
- BULL H.J., 1896. - Cruise of the *Antarctic* to the South Polar Regions. 243 p. London, New York: Edward Arnold.
- CALLE B., 1997. - La caverne des phoquiers. *AMAPOF*, 41: 14-15.
- CCAMLR, 1990-2008. Commission for the Conservation of Antarctic Marine Living Resources. *Stat. Bull.*, Vol. 1 (1970-1979) to 21 (1999-2008).
- CLARKE W.B., 1850. - Narrative of the Wreck of the *Favorite* on the Island of Desolation: Detailing the Adventures, Sufferings, and Privations of John Nunn; An Historical Account of the Island, and its Whale and Seal Fisheries. London, William Edward Painter. [Translated in French by J. Beaujé: un naufragé célèbre aux îles Kerguelen. John Nunn 1925-1829. *TAAF* 28 to 32, 33 (1964-1965)].
- DAVAINE P., 2000. - Première introduction des saumons. 25 ans déjà... La première tentative d'introduction du saumon à Kerguelen. *AMAPOF*, 48: 53-55.
- DAVAINE P., 2009. - Un envahisseur discret et "presque" inoffensif : la truite commune à Kerguelen. *AMAPOF*, 66: 36-40.
- DICKSON R., 2007. - The cruise of the Nantucket ships *Asia* and *Alliance* in consort to the Indian Ocean and the coast of New Holland, Australia 1791-1794. *Hist. Nantucket*, 56(1): 8-13.
- DOWNES M. & DOWNES E., 2006. - Sealing at Heard Island in the nineteenth century. In Heard Island: Southern Ocean Sentinel (Green K. & Woehler E., eds), pp. 184-195. Chipping Norton: Surrey Beatty & Sons.
- DUHAMEL G., 1987. - Ichtyofaune des secteurs indien occidental et atlantique oriental de l'océan Austral. Biogéographie, cycles biologiques et dynamique des populations. Thèse de Doctorat d'État, 687 p. Univ. Paris VI. Microfiche SN 87 200 447, 512 p. Institut d'Ethnologie.
- DUHAMEL G., 1993. - Campagnes SKALP 1987 et 1988 aux îles Kerguelen à bord des navires *Skif* et *Kalper*. Institut Français pour la Recherche et la Technologie Polaires. *Rapp. Campagnes Mer*, 93-01 : 1-614 (2 Vol.).
- DUHAMEL G., 1995. - Gestion des pêches aux îles Kerguelen. *Rech. Mar.*, 13: 16-17.
- DUHAMEL G., 2003. - La légine, pêche conflictuelle. Pêche légale et braconnage organisé. Cas du secteur indien de l'océan Austral. In: Exploitation et Surexploitation des Ressources marines vivantes, pp. 177-187. *Rapp. Sci. Technol.*, 17, Académie des Sciences. Paris: Lavoisier (Tec. & Doc).
- DUHAMEL G. & HUREAU J.C., 1981. - La situation de la pêche aux îles Kerguelen en 1981. *Pêche Mar.*, 1238: 272-279.
- DUHAMEL G. & HAUTECOEUR M., 2009. - Biomass, abundance and distribution of fish in the Kerguelen islands EEZ CCAMLR statistical division 58-5-1). *CCAMLR Sci.*, 16: 1-32.
- DUHAMEL G., GASCO N. & DAVAIN P., 2005. - Poissons des îles Kerguelen et Crozet, guide régional de l'océan Austral. *Patrimoines Nat.*, 63: 1-419.
- GHERASIMCHOOK V.V., BRODIN V.N., KLJAUSOV A.V., RUSSELO I.B., YISHKOV P.V. & ZAREMBA N.B., 1988. - Brief report of the joint Soviet-Australian expedition of the USSR FRV *Professor Mesyatsev* to the Australian Fishing Zone around the Territory of Heard and McDonald Islands, May-August 1987. CCAMLR Selected Scientific Papers, 1987. *CCAMLR Doc. SC-CAMLR-SSP*, 4: 75-103.
- GREEN K., 2006. - The marine mammals of Heard Island. In: Heard Island: Southern Ocean Sentinel (Green K. & Woehler E. eds), pp 166-183. Chipping Norton: Surrey Beatty & Sons.
- GUINET C., CHEREL Y., RIDOUX V. & JOUVENTIN P., 1996. - Consumption of marine resources by seabirds and seals in Crozet and Kerguelen waters: change in relation to consumer biomass 1962-1985 *Antarct. Sci.*, 8: 23-30.
- GUINET C., JOUVENTIN P. & WEIMERSKIRCH H., 1999. - Recent population change of the southern elephant seal at îles Crozet and îles Kerguelen. *Antarct. Sci.*, 11(2): 193-197.

- HEADLAND R.K., 1989. - Chronological List of Antarctic Expeditions and Related Historical Events: 730 p. Cambridge: Cambridge Univ. Press.
- JAMARC, 1977-1978. - Reports on the Kerguelen Islands area, 25(8), 25(21). [in Japanese]
- JONES A.G.E., 1971. - Island of Desolation. *Antarctic*, 6(1): 22-26.
- JONES A.G.E., 1986. - Ships Employed in the South Seas Trade, Vol. 1: 1775-1861. Roebuck Society Publication (Canberra) no 36: 276 p + 104 p of indices.
- KNECHT G.B., 2006. - Hooked. Pirates, Poaching and the Perfect Fish. 278 p. Rodale Inc. Holtzbrink.
- PAGE B., WELLING A., CHAMBELLANT M., GOLDWORTHY S.D., DORR T. & VEEN VAN R., 2003. Population status and breeding season chronology of Heard Island fur seals. *Polar Biol.*, 26: 219-224.
- PASCAL M., 1982. - Evolution numérique de la population d'éléphants de mer (*Mirounga leonina* L.) de l'archipel des Kerguelen au cours des 30 dernières années. In: Colloque sur les Écosystèmes subantarctiques, Station biologique de Paimpont (Univ. de Rennes), pp. 119-135. *CNFRA* 51.
- PASCAL M., 1985. - Numerical changes in the population of elephant seals in the Kerguelen archipelago during the last 30 years. In: Marine Mammals and Fisheries (Beddington J.R. *et al.*, eds), pp. 170-186. London: Allen and Unwin.
- PÉCHENART M., 2003. - Il y a 45 ans à Kerguelen. Véhicules à chenilles de la SIDAP : le Bren-Carrier. *AMAPOF*, 53: 52-53.
- ROBINEAU D. & DUHAMEL G., 2006. - Nouvelles données sur les cétacés des îles Kerguelen. *Mammalia*, 28-39.
- SLIP D.J. & BURTON H.R., 1999. - Population status and seasonal haulout patterns of the Southern elephant seal (*Mirounga leonina*) at Heard Island. *Antarct. Sci.*, 11: 38-47.
- SŁOSARCZYK W. & WYSOKINSKI A., 1980. - Ichthyological and fishery studies of the shelf fishing grounds in the region of Kerguelen Islands (Antarctic). *Pol. Polar Res.*, 1: 173-190.
- SOSINSKI J., 1981. - Comparative Biology of Antarctic Icefish *Champscephalus gunnari* Lönnberg, 1905 from the Antarctic. *Stud. Materialy B*, 48: 1-91. [in Polish]
- STARBUCK A., 1878. - History of the American Whale Fishery from its Earliest Inception to the Year 1876. 779 p. Washington: Government Printing Office.
- TAYLOR N.W., 1929. - Life on a Whaler, or Antarctic Adventures in the Isle of Desolation (1858). 208 p. New London: New London County Historical Society, Occasional Publications Vol. II.
- WILLIAMS R. & DE LA MARE W.K., 1995. - Fish distribution and biomass in the Heard Island zone (Division 58.5.2). *CCAMLR Sci.*, 2: 1-20.